Lecture Notes

UJ | SCHOOL OF MED

PHYSIOLOGY

Dr Saleem Khresha

019

النادي الطلابي
كلية الطب

Hematology/Blood

Body fluids are about 45 L (= 65% of the body weight) and 5 L of those 45 L are blood

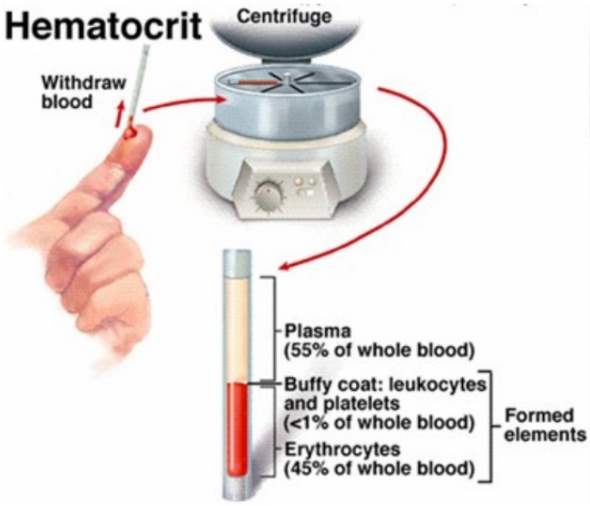
In centrifugation, blood cells precipitate

Cells = 45% of the whole blood

Plasma = 55% of the whole blood

Hematocrit (HCT)/Packed cell volume (PCV): it is the 45% of erythrocytes; it's the volume percentage of RBCs in blood.

About 2% of the hematocrit is plasma trapped/ retained between the erythrocytes because of the shape of these RBCs. Therefore, the 45% is not completely erythrocytes.



Blood Cells

Blood Cell Types	Approximate Normal Range (cells/μL)	
1. **Erythrocytes - Red blood cells**		In men more than women because of the effect of androgens in men
Men	4.3 – 5.9 x 100^4	
Women	3.5 – 5.5 x 100^4	
2. **Leukocytes - White blood cells**	4,500 – 11,000	Usually, the most abundant
a. Neutrophils	4,000 – 7,000	
b. Lymphocytes	2,500 – 5,000	
c. Monocytes	100 – 1,000	
d. Eosinophils	0 – 500	
e. Basophils	0 – 100	
3. **Platelets - Thrombocytes**	150,000 – 400, 000	
We can use per microliter (μL) or per cubic millimeter (mm^3). Microliters and cubic millimeters are identical unites.		

Constituents of the blood

Constituent	Amount/Concentration
Water	90% of plasma
Electrolytes (inorganic)	<1% of plasma
Na^+	142 mEq/l (142 mmol/l)
K^+	4 mEq/l (4 mmol/l)
Cn^{2+}	5 mEq/l (2.5 mmol/l)
Mg^{2+}	3 mEq/l (1.5 mmol/l)
Cl^-	107 mEq/l (107 mmol/l)
HCO^{3-}	27 mEq/l (27 mmol/l)
Phosphate (mostly HPO_4^{2-})	4 mEq/l (2 mmol/l)
SO_4^{2-}	1 mEq/l (0.5 mmol/l)
Gases	about 1% of plasma
CO_2	60 ml/100 ml plasma
O_2	0.2 ml/100 ml
N_2	0.9 ml/100 ml

Constituent	Amount/Concentration
Nutrients	About 3% of plasma
Glucose & other carbs	100 mg/100 ml
Amino acids	40 mg/100 ml
Lipids	500 mg/100 ml
Cholesterol	150-250 mg/100 ml
Vitamins	Traces
Trace elements	Traces
Waste products	about 1% of the plasma
Urea	<20 mg/100 ml
Creatinine	<1 mg/100 ml
Uric acid	5 mg/100 ml
Bilirubin	0.2-1.2 mg/100 ml
Proteins	6% of plasma (2.5 mmol/l)
Albumins	4.5 g/100 ml
Globulins (α, β, γ)	2.5 g/100 ml
Fibrinogens	0.3 g/100 ml
Prothrombins	<0.1 g/100 ml
Hormones	Traces

PH ranges between 0 to 14

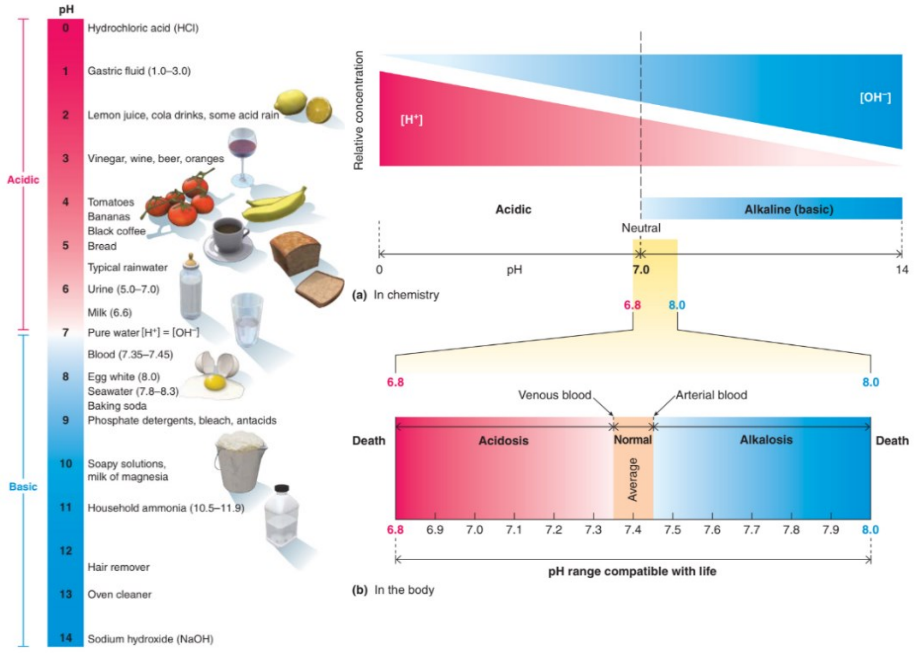
The pH of distilled water = 7

Below 7 acidic

Gastric juice in stomach = less than 2

Above 7 basic

Oven cleaner = highly basic



PH of the blood:

Average = 7.4

Range = 7.35 - 7.45

If blood pH falls below 7.35, **acidosis**.
If above 7.45, **alkalosis** (blood is more basic than normal)

If blood pH goes higher than 8 & less than 6.8, it causes death. Changes in Ph affects the enzymes, causes denaturation of proteins and affects Potassium – hydrogen levels. Also, pH values affect the CNS

The venous blood is slightly more acidic than arterial blood because of the H+ that is generated by the formation of H2CO3 from CO2 that was picked up from tissues.

General Functions of the Blood:

Blood is a complex liquid that performs a number of critical functions

1. It transports oxygen from the lungs to all cells of the body.
2. It transports carbon dioxide from the cells to the lungs.
3. It transports nutrients from the digestive organs to the cells.
4. It transports waste products from the cells to the kidneys, lungs, and sweat glands.
5. It transports hormones from endocrine glands to the cells.
6. It transports enzymes to various cells.
7. It regulates body pH through buffers and amino acids.
8. It plays a role in the regulation of normal body temperature because it contains a large volume of water (an excellent heat absorber and coolant).
9. It regulates the water content of cells, principally through dissolved sodium ions.
10. It prevents body fluid loss through the clotting mechanism.
11. It protects against toxins and foreign microbes through special combat - unit cells

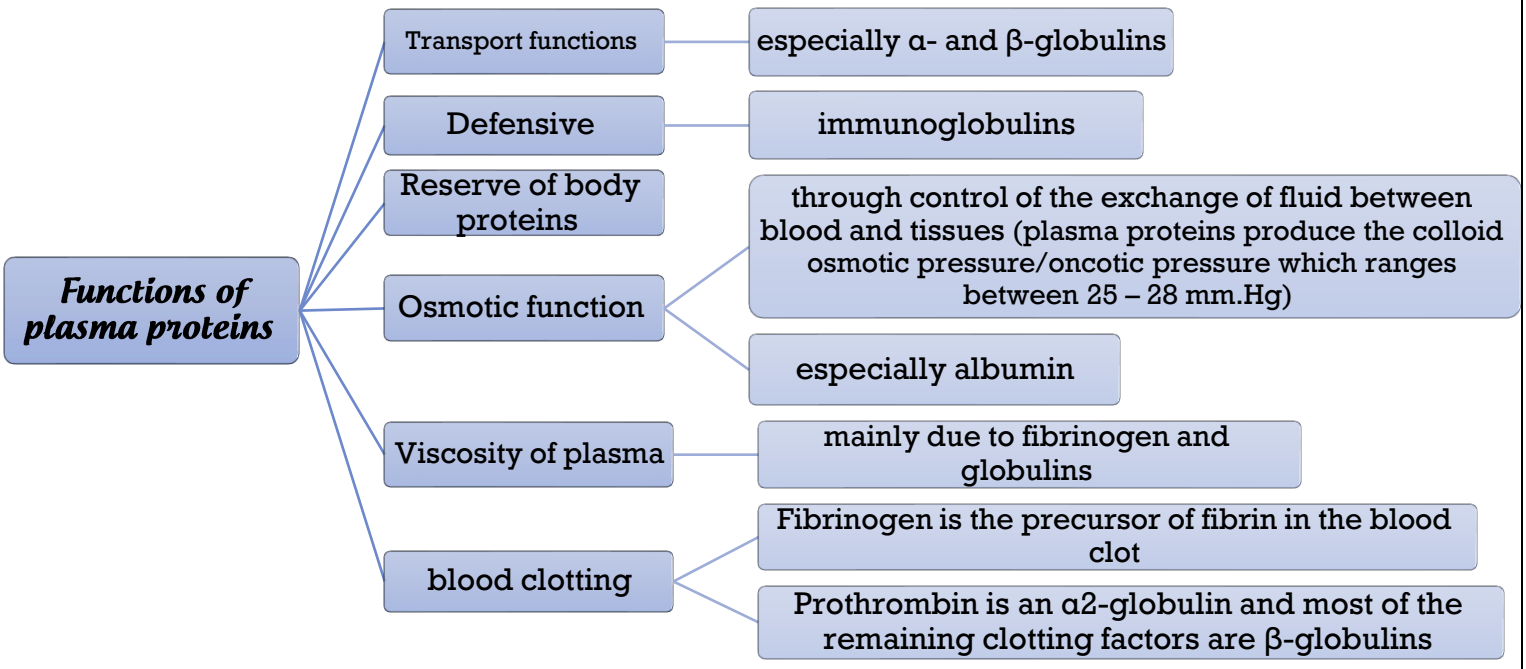
Plasma Proteins

There are close to 1400 different plasma proteins identified, which almost to a total of about 6 to 8 g of proteins/dL. They are generally all synthesized in the liver, except for the gamma globulins, which are produced by lymphocytes.

Plasma proteins are needed as building blocks of cells and tissues. They function as enzymes, hormones, antibodies and transporters, they contribute to plasma osmolarity and acid-base balance, they serve as an energy source under limiting conditions

The main plasma proteins are:

1. Albumin (most abundant)
2. Globulins
3. Fibrinogen
4. Prothrombin



Enzymes and many hormones are proteins. Proteins are composed of amino acids and have molecular weights of a few thousand to a few hundred thousand. More than 20 common amino acids form the building blocks for proteins. Of these, nine are considered essential and must be provided from the diet. Although the nonessential amino acids are also required for normal protein synthesis, the body can synthesize them from other amino acids.

Complete proteins are proteins that can supply all essential amino acids in sufficient amounts to support normal growth and body maintenance.

- Examples: eggs, poultry, and fish.

Incomplete proteins don't provide all of the essential amino acids in amounts sufficient to sustain normal growth and body maintenance.

- Examples: proteins in most vegetables and grains. Vegetarians need to eat a variety of vegetables and soy proteins to avoid amino acids deficiencies.

The Amino Acids Found in Proteins

Essential	Nonessential
Histidine	Alanine
Isoleucine	Arginine
Leucine	Aspartic acid
Lysine	Citrulline
Methionine	Glutamic acid
Phenylalanine	Glycine
Threonine	Hydroxyglutamic acid
Tryptophan	Hydroxyproline
Valine	Norleucine
	Proline
	Serine
	Tyrosine

Blood Volume

Approximate percentage distribution of the blood volume in an adult at rest

Veins	65% - 75%
Arteries	10% - 15%
Capillaries	5%
Heart	5%
Lungs	10%

The **veins** have the highest amount of blood then **arteries**

There are variations in blood volume under different physiological conditions. The factors that affect the blood volume:

Males

- **Sex**: for males, the blood volume is 10% higher than in females. This is due to greater number of RBCs.

Female

- **Pregnancy**: blood volume rises due to increase in both cells and plasma. In pregnant women, blood volume increases on the average by about 20 to 30%, in the last few weeks of pregnancy
- **Muscular exercise**: it raises the blood volume probably due to contraction of the spleen: as it contains blood, it increases blood volume
- **Altitude**: at higher altitude the blood volume will rise. Due to hypoxia, the number of RBCs will increase so blood volume increases
- **Adrenaline** injection: high adrenaline rises blood volume probably due to Contraction of the spleen
- **Posture**: In erect posture (standing), there is about 15% diminution of total plasma. It passes out into the tissue spaces.
- **Blood pressure**: Rise in B.P lowers blood volume by pressing out more fluid into the tissue spaces

RBCs (Erythrocytes)

RBCs are non-nucleated, circular, biconcave cells. They change their shape as they pass through the blood vessels, but they don't leave the vessels.

Dimensions of RBCs: **(important)**

1. MCV (mean cell volume): 80- 90 fL or μ^3.
   [fL (femtolitre) = μ^3 (micron cubic)]
2. Surface area: 135 ± 16 μm^2.
3. Diameter: 7.5-7.8 µm

When the previous 3 change, the maximum & minimum thickness change.

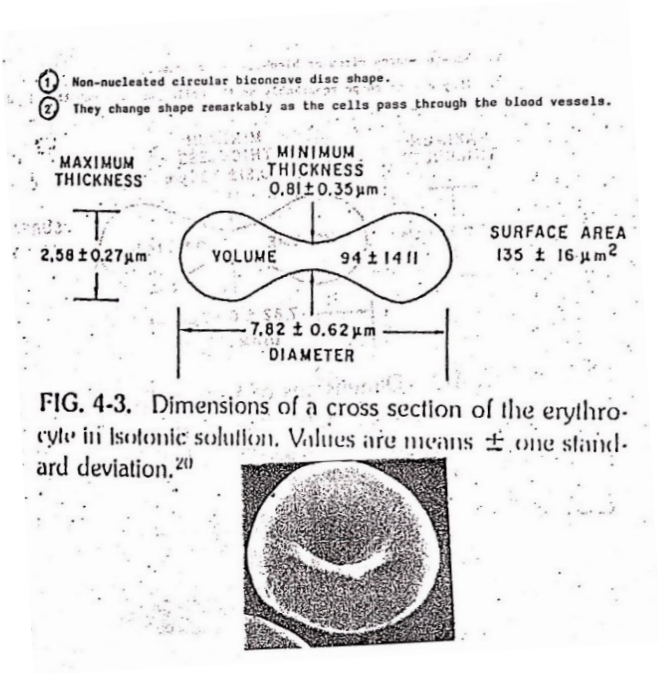


FIG. 4-3. Dimensions of a cross section of the erythrocyte in isotonic solution. Values are means ± one standard deviation.[20]

Done by:
Raneem AL-Zoubi

Corrected by:
Tayseer Mohamoud